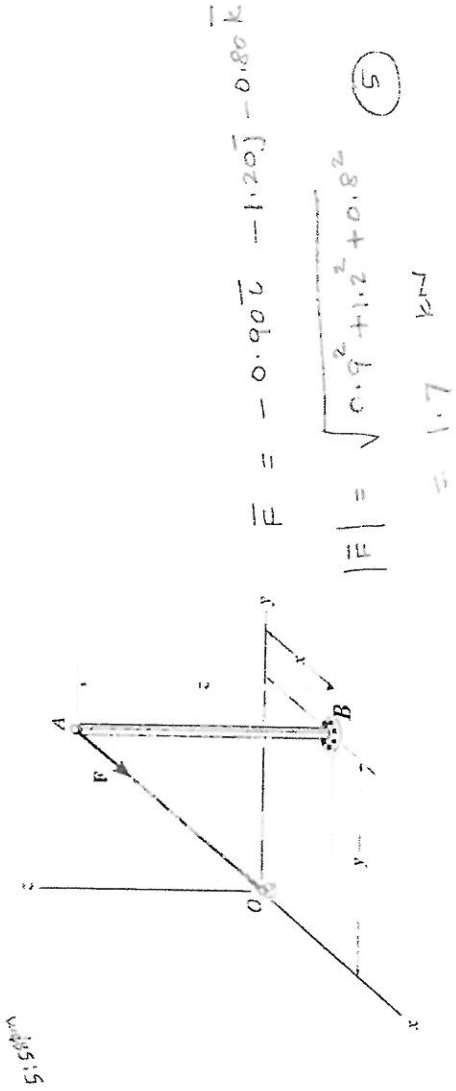


- Q1. Cable AO connects the top of the pole (point A) to the origin (point O). The force exerted by the cable at point A is given by $\vec{F} = \{-0.90\vec{i} - 1.20\vec{j} - 0.80\vec{k}\}$ kN. If the length of the cable is 17m,
- (1) Determine the coordinates (x, y, z) of point A
 - (2) Find the magnitude of the moment of the force in the cable about the base of the pole B.



$$\therefore \vec{u}_{AO} = \frac{-0.9}{1.7}\vec{i} - \frac{1.20}{1.7}\vec{j} - \frac{0.80}{1.7}\vec{k}$$

(5)

15

$$\vec{r}_{AO} = |\vec{r}_{AO}| \cdot \vec{u}_{AO} = 17 \vec{u}_{AO}$$

$$= -9\vec{i} - 12\vec{j} - 8\vec{k}$$

$$\therefore \vec{r}_{OA} = 9\vec{i} + 12\vec{j} + 8\vec{k}$$

$\therefore A \equiv (9, 12, 8)$ or
 $x = 9$
 $y = 12$
 $z = 8$

(5)

10

$$(2) \vec{M}_B = \vec{r}_{BA} \times \vec{F} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 0 & 0 & 8 \\ -0.9 & -1.2 & -0.8 \end{vmatrix}$$

(5)

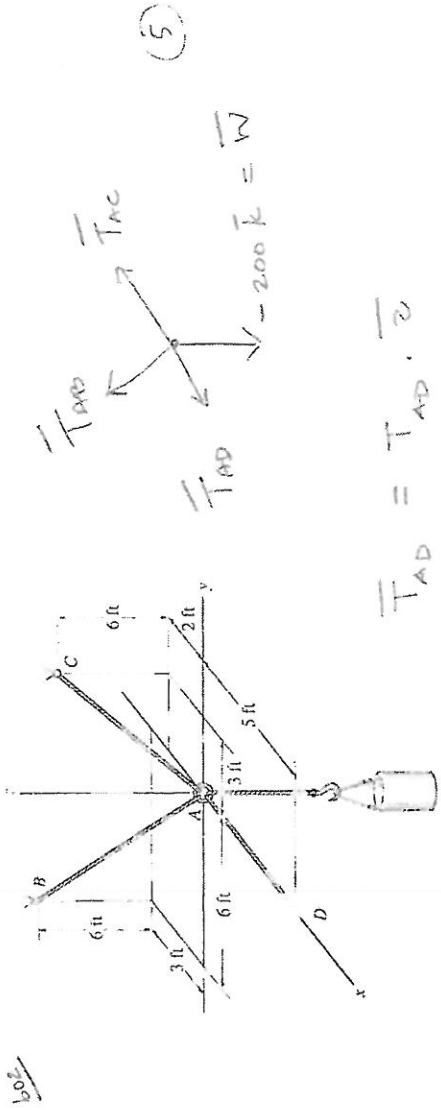
$$= (0 + 9.6)\vec{i} + (-7.2 - 0)\vec{j} + 0\vec{k}$$

$$= 9.6\vec{i} - 7.2\vec{j}$$

$$|\vec{M}_B| = \sqrt{9.6^2 + 7.2^2} = 12 \text{ kNm}$$

(5)

- Q2. A 200-lb cylinder is supported by cables AB, AC and AD as shown in the figure. Determine the force in cables AB, AC and AD.



$$\vec{T}_{AD} = T_{AD} \cdot \vec{u}$$

$$B \equiv (-3, -6, 6)$$

$$\vec{r}_{AB} = -3\mathbf{i} - 6\mathbf{j} + 6\mathbf{k}; \quad |\vec{r}_{AB}| = \sqrt{7+36+36} = 9$$

$$\vec{u}_{AB} = -\frac{1}{3}\mathbf{i} - \frac{2}{3}\mathbf{j} + \frac{2}{3}\mathbf{k}$$

$$\vec{T}_{AB} = -\frac{T_{AB}}{3}\mathbf{i} - \frac{2T_{AB}}{3}\mathbf{j} + \frac{2T_{AB}}{3}\mathbf{k}$$

$$C \equiv (-2, 3, 6)$$

$$\vec{r}_{AC} = -2\mathbf{i} + 3\mathbf{j} + 6\mathbf{k}; \quad |\vec{r}_{AC}| = \sqrt{4+9+36} = 7$$

$$\vec{u}_{AC} = -\frac{2}{7}\mathbf{i} + \frac{3}{7}\mathbf{j} + \frac{6}{7}\mathbf{k}$$

$$\vec{T}_{AC} = -\frac{2T_{AC}}{7}\mathbf{i} + \frac{3T_{AC}}{7}\mathbf{j} + \frac{6T_{AC}}{7}\mathbf{k}$$

for eq^{bm} $\vec{T}_{AB} + \vec{T}_{AC} + \vec{T}_{AD} + \vec{W} = \vec{0}$

Considering \mathbf{i} terms $-\frac{T_{AB}}{3} - \frac{2T_{AC}}{7} + T_{AD} = 0$ — (1)

\mathbf{j} terms $-\frac{2T_{AB}}{3} + \frac{3T_{AC}}{7} = 0$ — (2)

\mathbf{k} terms $\frac{2T_{AB}}{3} + \frac{6T_{AC}}{7} - 200 = 0$ — (3)

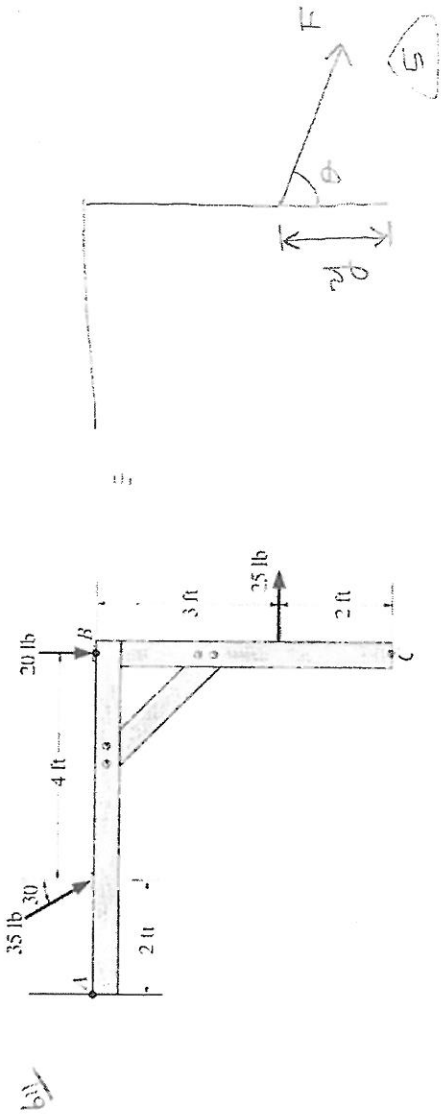
$$(2) \Rightarrow T_{AB} = \frac{9T_{AC}}{14};$$

$$(3) \Rightarrow \frac{2}{3} \cdot \frac{9T_{AC}}{14} + \frac{12T_{AC}}{14} = 200$$

Solving 5

(3)

- Q3. Replace the force system acting on the frame by an equivalent resultant force and specify where the resultant line of action intersects member BC from point C.



$$\rightarrow F \sin \theta = 35 \sin 30 + 25 = 42.5 \quad \text{--- (1)}$$

$$\uparrow - F \cos \theta = -20 - 35 \cos 30 = -50.3 \quad \text{--- (2)}$$

$$\frac{(2)}{(1)} \Rightarrow \tan \theta = 0.2419 \quad \theta = 40.2^\circ \quad \checkmark$$

$$\textcircled{1} \Rightarrow F = \frac{42.5}{\sin(40.2^\circ)} = 65.86 \text{ lb} \quad \text{--- (10)}$$

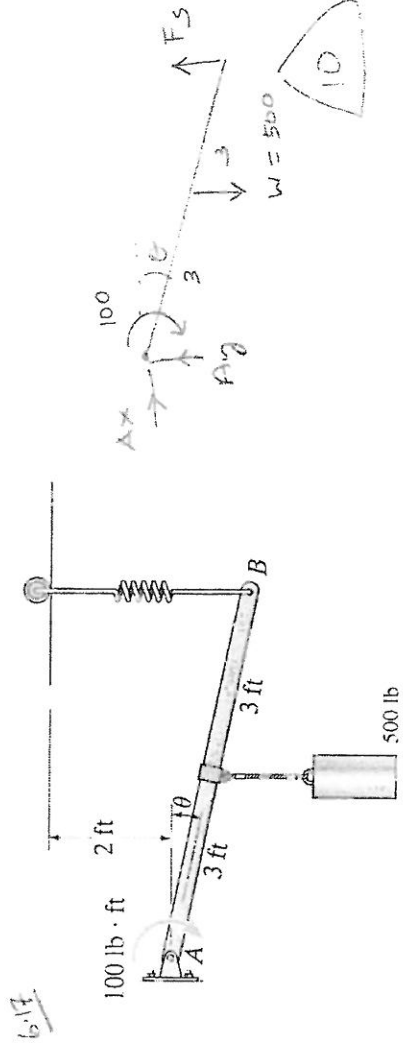
$$\uparrow \sum M_C \quad (F \sin \theta) \cdot y = 25(2) + (35 \sin 30)(5) - (35 \cos 30) \cdot 4$$

$$42.5 y = 50 + 87.5 - 121.24 \quad \text{--- (10)}$$

$$y = 0.383 \text{ ft}$$

Resultant force at 0.383 ft from C.

- Q4. The rod AB is supported by a pin at A and a spring at B. It is subjected to a clockwise couple moment of 100 lb·ft and supports a weight of 500 lb at the midpoint. The spring has an unstretched length of 2 ft. The angle $\theta = 20^\circ$ when the system is in equilibrium. Determine the stiffness of the spring and the support reactions at A.



$$\sum M_A = 0$$

$$(6 \cos \theta) \cdot F_s - (3 \sin \theta) W - 100 = 0$$

$$F_s = \frac{W}{2} + \frac{100}{6 \cos \theta} = 267.4 \text{ lb}$$

$$\text{Stretch, } s = 6 \sin^2 \theta = 2.05 \text{ ft}$$

$$\text{Stiffness } k = \frac{F}{s} = \frac{267.4}{2.05} = 130 \text{ lb/ft}$$

$$\sum F_x = 0 ; A_x = 0$$

$$\sum F_y = 0 ; A_y = W - F_s = \underline{\underline{232.6 \text{ lb}}}$$

6.13